El Niño Bulletin #1

VAM unit
JHB

World Food Programme

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Highlights:

- A moderate El Niño event is underway.
- Drier-than-normal conditions will therefore persist across much of the region throughout the remainder of 2002 and the 2003 growing season. For some areas, however, wetter-than-normal conditions will prevail through December 2002, with drier conditions following thereafter.
- Areas in southern Africa that are currently vulnerable to food insecurity are likely to become even more so into next year, and selected households will need external assistance to save lives, and/or to protect assets, livelihoods, and the environment.
- Crop yield reductions from 20-40% are possible in southern Zimbabwe, Lesotho, eastern Botswana, and southern Mozambique, with reductions of 10-20% possible in northern Zimbabwe, southern Malawi, southern Zambia, Swaziland, and parts of South Africa.
- Other areas of the region not currently food insecure will continue to require careful monitoring, especially central Mozambique, northern Zambia, southeastern Angola, and Botswana.
- With the present reduction in availability of the local staple-food supply combined with other shocks that have reduced poor households' ability to access food, and with the prospect that staple crop yields next year will again be low because of the El Niño event, it would be appropriate to conduct assessments in urban areas regionwide as the first step in preparing contingency and logistics plans for food assistance to urban populations.

This first edition of the Bulletin contains an explanation of what an El Niño event actually is, the most recent forecast, an update of current conditions, and a discussion of El Niño-associated drought conditions on the region's important staple crops.

An El Niño Primer and the Current Forecast

El Niño events are composed of an oceanic and an atmospheric component. Climatologists broadly agree that it is the reduction in magnitude of the low-level easterly (i.e., *from* the east) winds blowing off the South American Andes that initiates an El Niño cycle. What actually causes this reduction remains far from clear, but the Madden-Julian Oscillation (MJO) is believed to play a role.[1] In the Pacific Ocean, El Niño events cause a shift eastward of warm surface water; this is generally discussed in terms of temperature *anomalies*, i.e., departures (in °C) from average values. Below the surface, the thermocline (a distinct and abrupt change in water temperature) sinks in the eastern Pacific as warmer surface waters move in from the west. The atmosphere responds to these changes in ocean conditions by an early indicator – a switch in the magnitude of surface air pressure between Tahiti, in the central Pacific, and Darwin, in the western Pacific. During normal and La Niña conditions, the pressure at Tahiti is greater than that at Darwin. Since air flows from high pressure to low, surface winds blow from Tahiti to Darwin (i.e., easterly), and they maintain the surface warm-water pool off Indonesia. During an El Niño event, the air pressure reverses, and winds die down or blow from west to east, allowing the warm-water pool – which piles up water in the western Pacific so that the sea level is 80 cm higher in the western Pacific than the eastern – to flow eastward, strengthening the El Niño conditions. Because the surface air pressure swings back and forth between El Niño and normal/La Niña events, the term *Southern Oscillation* is the one used.

[1] The Madden-Julian Oscillation (MJO) has been a major source of week-to-week and month-to-month variability in the atmospheric circulation of the tropics and subtropics. The MJO contributed to substantial weakening of the low-level easterly winds throughout the equatorial Pacific during late May and again in early July. During August the MJO weakened, as a more persistent pattern of weaker-than average easterly winds and enhanced cloudiness and precipitation developed over the central equatorial Pacific. The variability in this oscillation made it difficult to conclusively confirm the presence and magnitude of the current El Niño event.

El Niño conditions have prevailed for the past several months, as sea-surface temperature (SST) anomalies (departures from average) remained greater than +1°C throughout the central-equatorial Pacific between 175°E and 130°W, and positive subsurface temperature departures and a deeper-than-average oceanic thermocline prevail throughout most of the equatorial Pacific. Atmospheric indicators of an El Niño include consistently negative values of the Southern Oscillation Index (SOI) since March 2002, and weaker-than-average low-level easterly winds since May 2002 throughout the equatorial Pacific. In addition, since August above-average precipitation was observed over the tropical Pacific, especially in the vicinity of the date line (180°W), while drier-than-average conditions prevailed over many areas of Indonesia (Climate Prediction Center, National Oceanic and Atmospheric Administration [NOAA]). These oceanic and atmospheric conditions reflect the presence of El Niño.

Most coupled model and statistical model forecasts indicate that El Niño conditions are likely to continue through the end of 2002 and into early 2003. Although there is some uncertainty in the forecasts about the timing and intensity of the peak of this warm episode, all of the forecasts indicate that it will be weaker than the 1997-98 El Niño, which has been classified as an "extreme" event. It is important to confirm, then, that the global impacts of this warm episode should **generally be weaker** than those observed during the 1997-98 El Niño. However, **significant impacts are still possible in some locations**.

A Badly Missed Forecast: Flood rather than Drought during the 1997-98 El Niño Event

All El Niño predictions are based on the current conditions in the tropical Pacific, on the SST predictions, and on results from historical studies of the effects of ENSO. For the 1997-98 El Niño, NOAA expected drier-than-average conditions to prevail over southeastern Africa during the event.

Figure 1 shows the NOAA forecast for the 1997-98 El Niño, and compares rainfall probability with "normal" rainfall (measured from 1961 to 1990) across the region. Note that the word *normal* appears consistently within quotation marks; rainfall across any tropical/subtropical country in the world is largely governed by what are termed *stochastic processes* – that is, it's often a matter of chance whether or not rain falls in any particular place. What the term stochastic means has been observed by many people driving across featureless flat land: it can be pouring rain one moment, and a few meters further along the road, the car emerges into bright sunshine and a dry road. As well, weather is often regulated by chaos – you may have heard the aphorism that a butterfly flapping its wings in China can affect the weather in California. The role played by *chaotic systems* from year-to-year as well as within years means that little consistency can be expected. Lack of interannual consistency – or a high variability – of rainfall is, however, especially prevalent in the drier areas of the region, and thus "normal" standard deviations from an expected average annual or seasonal rainfall can be quite high.[2]

The 1997-98 El Niño episode is within recent enough memory to justify some degree of skepticism regarding southern African climatological forecasts, for where drought was predicted, a wet season ensued. This missed forecast arose because the severity of the 1997-98 episode was unanticipated, and the event's rapid escalation was also unprecedented; ultimately, the locus of the forecasted southern African drought was pulled out to sea, and thus failed to influence the region. In addition, an

[2] Over southern Africa, early summer rains are dominated by low-pressure troughs connecting the tropical and temperate zones. More precisely, these troughs funnel moisture from the Inter-Tropical Convergence Zone (ITCZ) southward. The climatology changes shortly after mid-summer, moving away from temperate toward more tropical influences as the ITCZ reaches its southernmost position over the continent. The South African weather service finds January rainfall hardest to forecast, since this month is the boundary between the temperate and tropical climatologies. Late summer cyclones can approach the region from the east, and sometimes provide relief to drought-stricken areas. But high pressure systems can block tropical cyclones from moving onshore, and mid-level subsidence will often suppress convective rainfall. Shifting conditions from year-to-year are the norm rather than the exception.

as-yet poorly understood Indian Ocean oscillation overrode the influences on the region of the Pacific event.

What must be understood is that climate predictions remain an inexact science, and asking for precision is oblivious to the reality that precision is impossible. In particular, El Niño events can be understood by analogy – that of a large rock dropped into the “pond” of the Pacific ocean, from which ripples emanate outward to affect climate globally through a process termed *teleconnection*. Since there are simultaneously other linked ocean-atmosphere processes in the southern Atlantic and Indian oceans that can locally overlay the effects of an El Niño, accurate forecasts are error-prone. The best that climatologists can achieve is to provide *probable* scenarios.

Rainfall probability forecasts for the 2002-03 El Niño are shown in Figure 2. Ninety-three percent of climate model outputs predict that most of southern Africa will have “normal” to sub-normal rainfall through March 2003.[3]

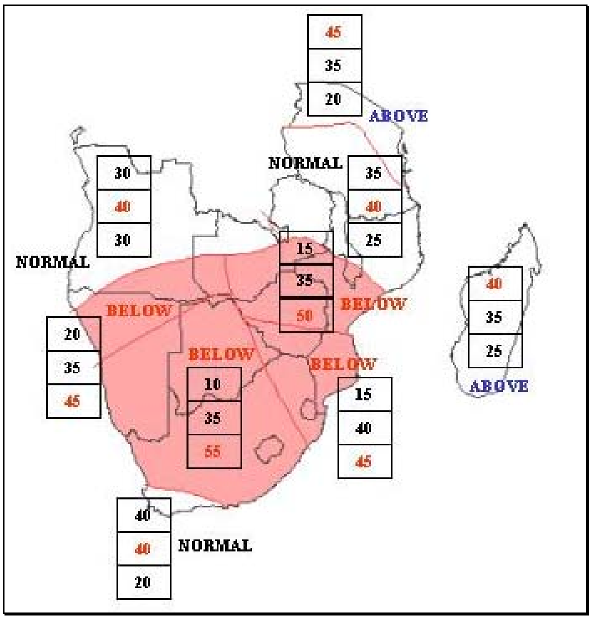

Figure 1. Probabilities of rainfall during the 1997-98 rainy season compared to the 1961-1990 average. The stacked blocks for each region indicate the probabilities of rainfall in each of the three categories, below, near-, and above normal. The top block’s number indicates the probability of rainfall occurring in the above normal category, the middle number corresponds to the probability of near-normal conditions, and the bottom to below normal conditions. Source: http://www.sadc-fanr.org.zw/rrsu/monitor/windhoek.htm

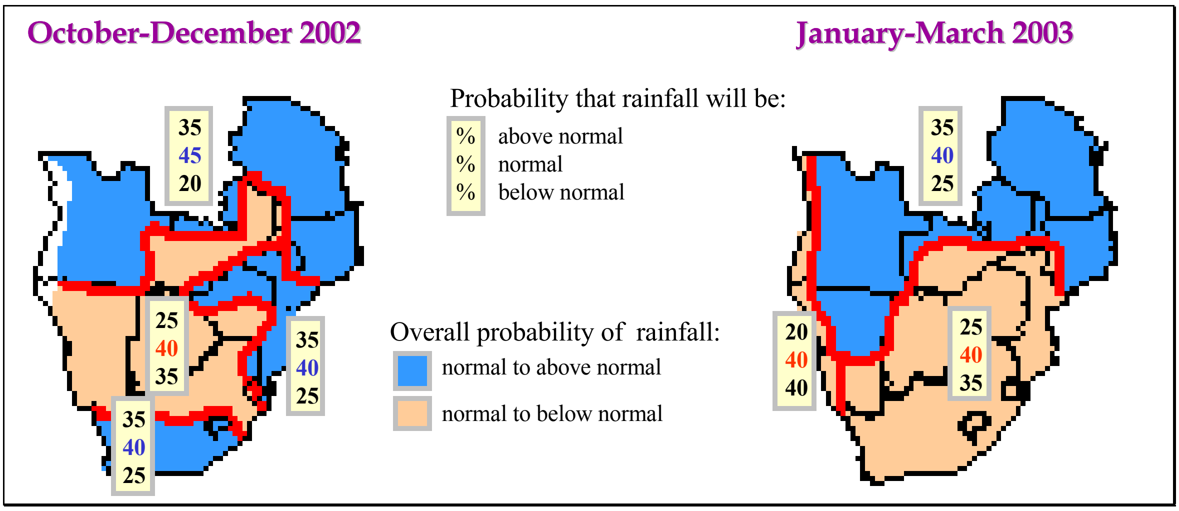

Figure 2. Rainfall probability forecasts for the first half (October-December 2002) and the second half (January-March 2003) of the main crop season. Modified from: *Regional Emergency Food Security Assessment Report*, SADC-FANR, September 2002.

[3] See also http://iri.columbia.edu/climate/ENSO/.

Impacts on Food Security of Weak and Moderate El Niño Events across Southern Africa

Having made the point that climate forecasts are, truly speaking, probability estimates, crop forecasts can also be made, but are obviously prone to the same problems regarding precision as climate forecasts themselves – more so, in fact, since soil and potential evaporation factors should also be taken into account. Nevertheless, FEWS has undertaken several analyses:[4]

- Overall, the "crop water satisfaction" outlook under conditions of weak El Niño is very similar to long-term "normal" conditions.
- Importantly, however, weak El Niño events are associated with **heavy November rains** across eastern Zimbabwe and southern Mozambique, with accumulations as much as twice the "normal." These rains could well make food **transportation along unpaved roads difficult or impossible**.
- Under moderate El Niño conditions, **crop yield reductions of 20-40%** for parts of Zimbabwe (Matabeleland-South, Matabeleland-North, and Masvingo), eastern Botswana, southern Mozambique, and Lesotho are likely.
- Areas with approximately **a 10-20% reduction in crop yield** include parts of South Africa, southern Botswana, southern Zambia, southern Malawi, Swaziland, and northern Zimbabwe (Mashonaland).

More locally, and as the growing season progresses, the VAM unit will make near-real-time estimates of crop yield potentials. These must be recognized as being *localizers of potential future problems* rather than definitive indications of food insecurity, since the empirical equations on which they are based are simple approximations of global average conditions for subtropical/tropical areas, and premised on well-distributed growing season rainfall. The empirical equations below are provided for readers' use in local areas, with the caveat that far superior crop models do exist and should be used if feasible.

Maize: [Yield Potential (%) = [rainfall (mm) × 0.25] – 75], where zero yield can be assumed if rainfall <300 mm during the growing season.[5]

Note also that maize seedlings will likely perish if no rain falls for 15 days post-sowing, and thus there's a possibility that seed distributions will be necessary. There is another critical period roughly midway through the growing season when the plants flower,[6] where insufficient available soil moisture for as little as 2 weeks can result in a 20% reduction of yield, and if of greater than 6 weeks duration, from a 70-100% reduction. WFP will strive to provide early warning of such occurrences as the next growing season progresses.

Pearl millet: [Yield Potential (%) = 127 – [13,734 / rainfall (mm)]], where zero yield can be assumed if rainfall <110 mm during the growing season.[7]

Sorghum: [Yield Potential (%) = [rainfall (mm) × 0.182] – 27.27], where zero yield can be assumed if rainfall <150 mm during the growing season.[8] However, note that sorghum is often grown entirely on stored soil water in some regions, on growing-season rainfall in others, and in yet others on a combination of the two. Thus the yield potential – rainfall relationship may be relatively weak in some areas, and available local knowledge is critically important. Future maps of sorghum yield potential will assume initial dry soils.

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4 http://www.reliefweb.int/w/rwb.nsf/6686f45896f15dbc852567ae00530132/8cd4f8df2199e3b849256c4d0008770f?OpenDocument

5 Source of equation: CIMMYT, personal communication with author.

6 Also known by the technical term "anthesis-silking," and by the less technical "flowering-tasselling."

7 Van Oosterom, E.J. *et al*., 1996. Effect of water availability pattern on yield of pearl millet in semi-arid tropical environments. *Euphytica* **89**: 165-173. The data from Figure 1 were reconstructed and run through CurvExpert™, with the resultant equation for a hyperbolic fit. The original equation is [Yield (g/m^2) = 318 – [34,334 / rainfall (mm)]]; ICRISAT (personal communication with author) stipulates yield saturation at 500 mm of well-distributed growing-season rainfall.

8 Source of equation: Texas Technical University, personal communication with author.

At growing point differentiation (GPD), the sorghum plant switches from strictly vegetative growth to reproductive growth. In most sorghum hybrids, the GPD occurs about 30 to 35 days after emergence. If conditions are very dry, GPD is hindered. At flowering the actual number of seed is determined, and exceptionally hot, dry weather will curtail pollination, limiting seed establishment. Since sorghum typically flowers over a period of about 4 to 9 days, one single hot day may not necessarily drive yield potential down, but several consecutive days will do so. Finally, adequate soil moisture is necessary during the grain fill stage to increase grain size and weight.

Cassava and sweet potato: These crops are generally resistant to drought. However, a combination of excessively wet soil conditions soon after a sweet potato crop is planted followed by a mild drought as the tubers increase in size causes a marked depression on tuber yield. This is commonly attributed to the drought, but in fact it is the combination of climatic extremes that causes the damage. Sweet potatoes are also susceptible to frost damage, which is more likely in high mountain valleys if the nights are clear and dry – typical conditions encountered during El Niño droughts. A single frost affects sweet potato plants at various stages of development differently. A frost one month after planting will retard the crop reaching maturity by between 1 and 3 months. A frost 6 months from planting will retard maturity by up to 5 months in severely affected plants. Six to 9 months after planting a frost will cause tubers to rot almost immediately. Unless they can be harvested quickly they are lost, and because many are not yet mature, total loss of this planting can occur. But a frost 9 to 12 months after planting often does little damage to the tubers, which can be harvested for up to 3 months after the frost. In general, one frost can be easily coped with, but a number of frosts, 6 to 8 weeks apart, can completely destroy sweet potato production in high-altitude valleys.

Recapitulation: 2001-2002 Main Crop's Growing Conditions

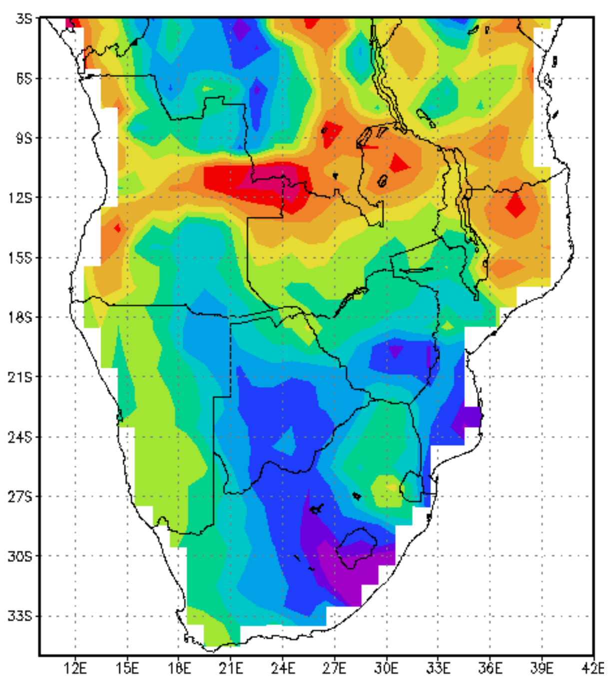
The main crop season for last year was characterized by "erratic rainfall."

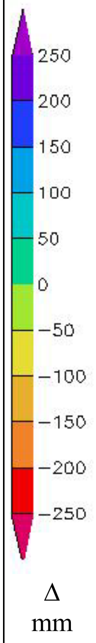
- October to December saw normal to above normal rains across most of the region. An exception was Malawi, where dry conditions prevailed in late November to early December, adversely impacting maize planted in mid-November. Lesotho's valley maize could not be sown as usual because of waterlogged soils.
- A meteorological drought struck most of the region from January to March. Again, Malawi was an exception, with floods damaging crops in late December and early January, normalizing thereafter, but by late February, drought struck even here.
- In mountainous Lesotho, March frosts and hailstorms severely impacted the standing maize that had survived the season's flood-drought cycle.

These conditions are shown in Figures 3a and 3b; Figure 3c depicts current rainfall (August – mid-October 2002). The maps are a collaboration between WFP and NASA's Goddard Space Flight Center. While not fully accurate as yet because of minor deficiencies in NASA's algorithms, these rainfall accumulation estimates, derived from satellites and ground stations, are among the best currently available. Note that the near-real-time map (Figure 3c) may not be as accurate, because the satellite images are unmodified by the ground-truthing provided by surface stations (and as shown by Figures 3a and 3b).

Recall that an El Niño event, if moderate in magnitude, is expected to further reduce food security across much of the region by decreasing growing-season rainfall or again causing rainfall to be highly erratic. Recall to that the latest forecasts predict the El Niño event to be of moderate magnitude.[9]

[9] http://iri.columbia.edu/climate/ENSO/currentinfo/archive/200210/update.html





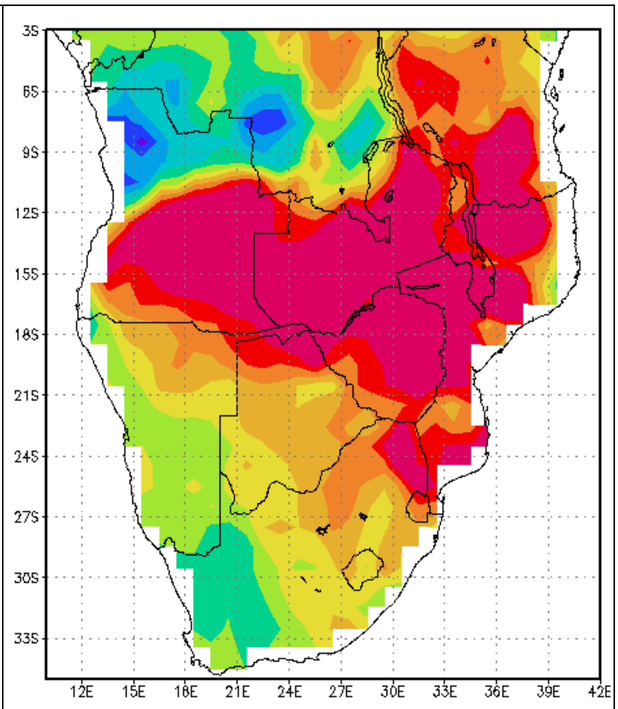
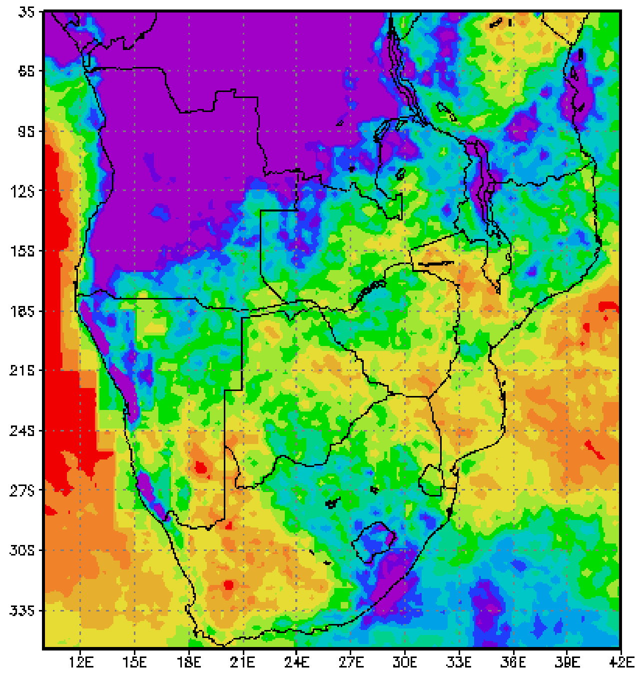


Figure 3a. October – December 2001 rainfall anomalies derived from differences between these months and the same months of a 50-year average (1950-1999). Source: NASA-DAAC.

Figure 3a. January – March 2002 rainfall anomalies derived from differences between these months and the same months of a 50-year average (1950-1999). Source: NASA-DAAC.



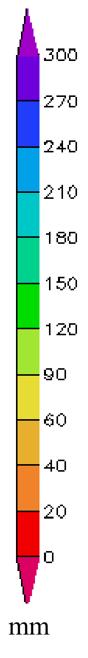


Figure 3c. August – mid-October 2002 rainfall accumulations. The spatial distribution of rainfall is much more precise than the maps above, since the grid resolution is 0.25° rather than the 1.0° of Figure 2a and 2b, which have "degraded" resolution because of the coarseness of the surface-level raingauge network. Also on the plus side is that the maps can be produced in near-real-time,[10] which therefore makes the product an excellent flood monitoring tool as well, for it can warn of heavy rains in upstream watersheds before the pulse travels and floods the lowlands.

Note, however, that NASA's algorithm for translating satellite data to rainfall accumulations is not yet perfect: It is incorrectly interpreting the thick stratus clouds on Namibia's coast as rainfall.

Questions may be directed to the author of this report via email, to Lenard.Milich@WFP.org. The next Bulletin will be completed in approximately one month.

[10] NASA currently uploads the necessary data with only a 2-day lag; the user interface is available at: http://lake.nascom.nasa.gov/daac-bin/trmm_analysis_html.pl?ctlFile=/ftp/data/6/3B42RT/3B42rt.ctl